Design and Administration of Dissolving Microneedle Patches In Human Subjects

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Dissolving microneedle patches contain micron-sized needles made of water-soluble biodegradable polymers that dissolve in the skin to deliver encapsulated vaccine. They offer the simplicity of patch application and the possibility to mitigate the logistical and safety challenges associated with using conventional hypodermic needles. To ensure reliability in the dose being delivered, it is important to understand the biomechanics of the skin and the parameters that affect insertion and dissolution of microneedles into skin. We are studying these parameters in a human study with placebo dissolving microneedle patches (i.e., containing no vaccine) to prepare for a planned phase 1 clinical trial of influenza vaccination using microneedle patches of similar design.

We fabricated microneedle patches suitable for use in humans using a micromolding process that employs excipients (polymers and sugars) found in FDA-approved products. The study is approved by the Georgia Tech IRB and informed consent is obtained from all participants.

The parameters studied are:

1. **Effect of microneedle geometry on efficiency of insertion into skin:** We expect that microneedle size and needle to needle spacing will be critical parameters affecting biomechanics of insertion into the skin. We therefore designed microneedles of different geometries and inserted them using spring-loaded applicators that apply varying amounts of forces. Initial findings show that a force of 45 N or greater was sufficient for reliable insertion, as determined by staining the skin with a dye to image sites of microneedle puncture, microscopically inspecting microneedle patches after insertion into the skin and assaying for the amount of needle dissolved.

2. **Kinetics of microneedle dissolution in the skin:** We inserted the patch in the forearm by pressing down with the thumb and left the patch on for varying amounts of time from 30 seconds to 15 minutes. Initial studies have shown microneedle dissolution in the skin within 5 – 10 min of insertion. [Fig 2 and 3]

3. **Skin tolerability of dissolving microneedles in terms of local irritation in the skin after patch insertion:** Skin tolerability has been good, with mild erythema observed localized to the site of patch application for up to two days

Ongoing studies are carrying these studies out using a range different microneedle patch geometries and using larger numbers of human subjects.



Fig 1. Skin insertion site showing minimal irritation immediately after microneedle patch insertion

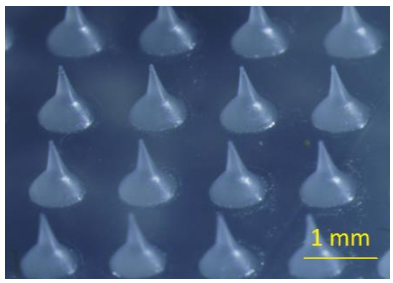


Fig 2. Dissolving microneedle patch before insertion

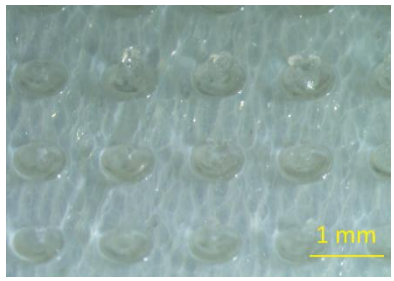


Fig 3. Dissolving microneedle patch after insertion and patch wear time of 10 min